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ENTOMOLOGICAL FACTORS AFFECTING FUTURE FORESTS.

My J. M. Miller

During the past twenty years applied forest entomology has become something of a factor in the protection of forests in the western United States and Canada. The diminishing timber supply of the United States has reached a point where the last large reservoir of high quality soft pine is found in the virgin forests of this regions. Western forests still contain something like 245 billion board feet of western yellow pine, sugar pine and western white pine. Under any system of forestry these forests have long been overdue for cutting because of overmaturity and inferior composition of the stand, but large areas are still being held in reserve awaiting the development of transportation and favorable markets.

It has been generally recognized that barkbeetles kill the more valuable species of pine to such an extent as to threaten investments in these holdings. The entomologist has developed methods of direct control in combatting barkbeetle infestations. These methods consist of searching out the infested trees and destroying the broods of insects which are under or in the bark by burning or exposure to weather. It has been demonstrated that these methods will materially reduce barkbeetle losses when properly applied. Several large scale projects have been carried out and about half a million dollars has been invested since 1910 by federal and private owners in this form of protection.

The cutting of these virgin forests is rapidly progressing and their ultimate commercial exhaustion is only a question of years. To replace

them the forester plans to grow and protect new crops of timber in which he will control the composition of the stand, the age of rotation, and other factors governing growth and quality.

Unless these forests of the future can be protected against heavy losses from insects, the practice of forestry will become unprofitable. What then will be the conditions and factors with which the entomologist must contend in insuring the protection of these new forests against insect losses and what will be the nature of the problems to be expected?

The most important change now expected in shifting from natures methods to man-directed forestry, will be a decided shortening of the rotation of growth. Timber must be harvested before it passes beyond the period of most rapid growth. This probably means that trees will be cut between the ages of 50 to 100 years instead of reaching the mature age of 200 years and over as is the case in virgin forests. An increase in the density of the stands, and the encouragement of the more valuable species will also be the aim of silvicultural practices.

Obviously under this scheme of forestry the entomological problems will be first, those that affect the restocking of cutover lands, such as loss of seed trees, damage to reproduction and loss of trees reserved for increment and second cutting. The protection of young to middle aged stands of second growth will follow. In neither case will conditions be entirely comparable to those that now exist in virgin forests.

In order to meet the demands of owners who are interested first in protecting the mature timber that they now have, forest entomology has

been heavily concentrated on the problems of direct barkbeetle control and but little progress has been made in studying the type of problems that may affect future crops of timber. Forest pathology on the other hand has made a distinct advance along this line in pointing out to the Forester the factors which he must consider in determining the length of his crop rotation. It has already been shown that the short rotation offers decided advantages as a protection against wood-destroying fungi, as susceptibility to infection increases with the age of the stand and decay within the trees progresses with age. - "Basic Problems in Forest Pathology"- E. P. Meinecke, Journal of Forestry - Feb. 1917.

In the case of insects the short rotation will undoubtedly lessen the hazard of the loss of large mature trees from barkbeetle attacks such as result from the infestations with which we are now dealing, but the change in growth conditions may develop an entirely different type of infestation. As yet only a few cases have been brought to light which are indicative of the entomological problems we are approaching in the management of forest lands. The following studies which were made in California in the yellow pine sugar pine type are cited because of their bearing upon the practice of forest management:

Insect Losses on National Forest Sale Areas
Sierra National Forest.

A very recent development has uncovered a definite relation between insect losses and the marking practice employed on National Forest timber sales. In recruiting some of the older sale areas on this forest to determine the extent to which they were being restocked and the probable increment

that is occurring, Forest Examiner, Sanford noted that insect losses were apparently in excess of the increment altho the infestation amounted to what is usually termed normal and was in no way conspicuous. A cooperative study was therefore carried out with Mr. H. L. Person of the Bureau of Entomology with the object of determining the extent of these losses and the probable results upon the sale areas if they continue. *

* Sanford and Person. "Studies on the relation of Insect Loss to Management Policy, Sierra National Forest." June 6, 1924.

Altogether six sale areas covering 2680 acres of cutover lands were used as a basis. All of the trees over 12 inches D.B.H. which had been killed by barkbeetles within the past 3 years were marked and as a check, a similar cruise was made of forest lands in the vicinity which had not been cutover. The results were summarized by Mr. Person as follows:

"At present a combination group selection and selection system of marking is in use, the objects being to harvest ripe timber to insure the possibility of a second cut within 40 to 70 years wherever practicable, to secure reproduction following cutting, to accelerate growth of the remaining stand and to make the timber purchasers operation as profitable as the practice of good silviculture will allow. In general it calls for the cutting of all mature and decadent trees and the leaving of only thrifty trees. Thrifty mature trees are marked so as to leave a reserve of trees over 12" D.B.H. of four to ten thousand board feet per acre on good sites and from two to five thousand board feet per acre on poor sites.

On the average about three trees over 12" D.B.H. per acre or 1920 per section are left as a basis for the second cut. Considering only the five average Site II. areas studies we find that the average annual loss from barkbeetles (D. brevicomis and D. monticolae) is thirteen trees per section. If this continues for a fifty year period (some of the cutover areas are already nearly 20 years old) it will mean a loss of 650 trees or approximately 34% of the pines left for the second cut. If the cutting cycle be extended to 75 years the loss would be 975 trees or 50%. On the worst area studied the annual loss was 30 pines per section. A 65 year return on this area would see all of the pine trees which were left as a basis for the second cut, killed by barkbeetles. The least infested area would see 225 or approximately 11% of the trees killed.

In terms of annual increment we find that from 14% to 100% of the increment is lost thru insects with an average loss of approximately 50%."

It was also found that the number of insect killed trees per section on the cutover areas, corresponded very closely to the number of insect killed trees in adjacent virgin forests. In other words removal of

from 50% to 75% of the original stand by logging does not reduce the amount of insect loss on an area. The loss of 15 trees per section in a fully stocked stand is not considered serious but the loss of 15 trees per section on a cutover area may mean the loss of a relatively high percent of the timber left for increment and second cutting. In reserving a percent of the merchantable trees on a timber sale the forester deliberately cuts down his immediate revenue as well as the profits of the operator, in order to set aside a certain amount of his capital for further increment and to shorten the time in which a second cutting can be made profitably. This policy is open to serious question if it is shown that timber so reserved is subject to a loss around fifty percent of the total before it is harvested. The remedy apparently calls for either a clear cutting system in the yellow pine sugar pine type, depending upon either advance reproduction or planting for restocking of the area, or a system of protection which will eliminate the insect damage.

The above study was made where the infestation was normal or endemic, a condition which represents the lowest type of loss to be expected. An epidemic or barkbeetle outbreak, if it should occur, would very materially increase the rate of loss, and this is a potential factor to be considered in the protection of all cutover lands, especially after the areas have become restocked and the second growth well advanced.

Barkbeetle Epidemics in Second Growth on the Modoc National Forest.

On the northeastern slope of Sugar Hill in the Warner mountains of this forest the timber on an area of approximately 320 acres was killed by a fire which is estimated to have occurred about 1870 or earlier. Only

a few large yellow pine trees survived the fire and the area restocked with dense reproduction of yellow pine and white fir in nearly equal mixture. Soil and moisture conditions approximated Site I or Site II conditions resulting in rapid growth, and by 1918 the second growth had reached sapling and pole stages ranging from 6 to 24 inches D.B.H. The stand by this time was considerably overcrowded. The competition between yellow pine and white fir did not result in either species becoming dominant. About 1918 an epidemic of the mountain pine beetle broke out in the yellow pine. During the period from 1918 to 1923 practically all of the yellow pine within area of the old burn was killed, leaving a practically pure stand of white fir. In the general region were several other restocked burns of about the same age where the same conditions had resulted and where similar epidemics occurred at the same time. In all cases the infestation started in overcrowded stands on sites favorable to a dense growth of young trees and insects were the factor which ultimately determined the type and composition of the stand. Unfortunately it was the pine that was eliminated and less valuable fir was left to establish the ultimate forest cover.

These conditions are comparable to restocked timber sale areas where dense reproduction may result in an overcrowded condition of the second growth, and the results are significant of what we may expect in 30 or 40 years on some of the areas that are now being cutover.

Epidemics in Second Growth Yellow Pine Sierra National Forest.

In the Jerseydale district in the northern part of this forest some of the lower yellow pine belt was cutover to meet the needs of the mining activities from 1850 to 1870. These areas were soon restocked by advance reproduction mostly pure yellow pine. Growth conditions were favorable for yellow pine and by the time that pole and sapling stages were reached some overcrowding was evident. In 1913 an epidemic of western pine beetle combined with one or two species of Ips developed in these areas. This epidemic at its height attacked groups of from 20 to 50 trees. These groups were well distributed throughout the stand. Control measures were initiated and this together with the help of natural control factors, resulted in the subsidence of the epidemic within two years, with the loss of less than 25% of the second growth. The killing of the trees in groups, however, opened up the stand and relieved to some extent the overcrowded condition. From this viewpoint the epidemic was something of a benefit.

These cases are only suggestive of what we may expect in the management of future forests. Other types of infestation besides barkbeetles may play a much more important part than they do in the forest we are now protecting. Among these should be mentioned defoliations. The Spruce budworm is now of primary importance in the new England States and the hemlock looper has killed a vast amount of timber in the Pacific Coast region in the west. Western yellow pine has also been heavily defoliated by the Pandora moth and white pine butterfly. These outbreaks occur at long intervals and the period of their occurrence and severity of damage cannot be predicted. Direct control is at present impracticable. The only hope of dealing successfully with defoliations seems to be along the lines of regulation of forest growth and types so that conditions unfavorable to epidemic outbreaks will be maintained.

The purpose of this paper is only to point out that new problems in forest entomology are to be expected in the management of future forests, and to indicate in the light of our present information the nature of some of these problems. We have already enough evidence at hand to convince us that forest entomology will be concerned largely with methods of forest management and that the forester and the entomologist must work together in the solution of interrelated problems.

Notes to:

Miller, J. M.: Entomological Factors Affecting Future Forests.

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Page 2, line 2. The composition will be difficult to control.

Page 2, paragraph 2, line 2. I suggest: The practice of forestry may in many cases become unprofitable.

Page 2, paragraph 3, line 3. "Timber should be harvested ". In reality the rotation will in general be short enough to take care of that limitation.

Page 2, paragraph 4, lines 2-4. How does "Reproduction" in line 3 differ from "young stands of second growth"?

Page 3. The reference is: Forest Pathology in Forest Regulation.
U. S. Dept. Agr. Bull. 275. 1916.

Page 3, paragraph 2, lines 1-2. "The short rotation eliminates" the loss since there cannot be any large mature trees.

Page 4. Sanford and Person. Is that a manuscript or a publication? It should be so indicated.

Page 4, paragraph 3, lines 5-6. I suggest: "and at the same time make the ... operation as profitable ".

Page 4, paragraph 3, line 8. The reserved trees are not marked.

Page 4, paragraph 4. I am a little afraid of the data as well as of the conclusions. The loss should be given also in sizes of trees and in board feet.

On the basis of the figures given the total left is 1950 trees per section or 3 per acre. Compare this with the last lines of paragraph 2.

When were these areas cut? Is it permissible to figure on an annual loss from data running only 3 years back?

What is the loss in board feet and, above all, what is the computed annual increment? Is it the increment of the reserved trees or the total increment including reproduction?

Page 4, last paragraph. The number per section may be the same but the ratio appears tremendously increased. Which is meant?

E. P. Meinecke

E. P. Meinecke, Pathologist.